SAMPLES FROM DIFFERENTIATED ASTEROIDS; REGOLITHIC ACHONDRITES. J.S. Herrin[1,2], A.J. Ross[3,4], J.A. Cartwright[5], D.K. Ross[1,2], M.E. Zolensky[1], and P. Jenniskens[6]. [1]NASA Johnson Space Center, Houston, Texas, USA [2]ESCG Astromaterials Research Group, Houston, Texas, USA [3]Centre for Planetary Sciences, Joint UCL/Birkbeck Research School of Earth Sciences, London, UK, [4]IARC, Department of Mineralogy, The Natural History Museum, London, UK, [5]Max Planck Institut für Chemie, Mainz, Germany [6]SETI Institute, Mountain View, USA.

Introduction: Differentiated and partially-differentiated asteroids preserve a glimpse of planet formation frozen in time from the early solar system and thus are attractive targets for future exploration. Samples of such asteroids arrive to Earth in the form of achondrite meteorites. Many achondrites, particularly those thought to be most representative of asteroidal regolith, contain a diverse assortment of materials both indigenous and exogenous to the original igneous parent body intermixed at microscopic scales. Remote sensing spacecraft and landers would have difficulty deciphering individual components at these spatial scales, potentially leading to confusing results. Sample return would thus be much more informative than a robotic probe. In this and a companion abstract [1] we consider two regolithic achondrite types, howardites and (polymict) ureilites, in order to evaluate what materials might occur in samples returned from surfaces of differentiated asteroids and what sampling strategies might be prudent.

Interior components and the igneous history of parent bodies: Howardites and polymict ureilites provide examples of asteroid regolith that frequently contain diverse components from distant regions of the interior of their igneous parent body within individual meteorites [2,3,4]. This is advantageous for sample return because it demonstrates that large regions of the parent interior could be represented within a single modest-sized surface sample.

Exogenous lithologies: Meteorite evidence suggests that the surfaces of differentiated asteroids are littered with chondritic material that could comprise a significant fraction of any returned sample. A variety of chondrite types occur in both howardites and polymict ureilites, intermixed with indigenous components. The Almahata Sitta fall was a predominantly ureilitic asteroid consisting of 20-30% chondritic material [5,6]. The majority of individual specimens recovered from this fall, however, are monolithologic. From the Almahata Sitta example it is evident that a random “grab sample” taken from the surface of an asteroid might not give an accurate impression of bulk composition and might not be consistent with the reasons for which a particular asteroid were selected for sampling. Thus, by employing some type of smart sampling technology, a sample return mission would be more likely to recover materials representative of the target asteroid.

Exogenous water: Water might be an important consideration in targeting an asteroid or portion of an asteroid for sample return. Three recent Antarctic howardite finds, the paired Mt. Pratt (PRA) 04401 and PRA 04402 and Scott Glacier (SCO) 06040, are notable for their high proportion of hydrous carbonaceous chondrite clasts [7]. We interpret the carbonaceous chondrite material as a relative latecomer to these breccias, likely added to the parent asteroid by impacts that occurred well after differentiation of the igneous parent. They appear CM2-like, comprised largely of fine-grained hydrous phyllosilicate minerals. Low totals (80-90 wt%) from electron microprobe (EPMA) analyses of these clasts can give us some impression of the amount of water they contain (herein we use “water” as a generic term for either H_2O or structurally-bound OH- in minerals, phyllosilicates can contain both structural OH- as well as adsorbed water [8]). PRA 04401 is particularly chondrite-rich, with chondritic clasts >1 mm occupying more than half of the modal area of the sections we examined. This meteorite demonstrates the potential for hydrous lithologies with >5 wt% water to occur locally upon a nominally anhydrous parent. Delivered by impacts, hydrous materials might be concentrated in certain locations on an asteroid surface and observable by remote sensing instruments. Sampling missions could either target or avoid these regions, depending on the type of sample desired.

Implications and conclusions: Regolithic achondrites provide a preview of what samples might someday be recovered from the surfaces of differentiated and partially-differentiated asteroids. The diversity of materials fequently occurring within small volumes of these meteorites could be better examined in terrestrial labs than by robotic spacecraft. Spacecraft collecting samples from surfaces of differentiated asteroids should employ some form of selective sampling or perhaps impact randomization in order to ensure acquisition of desired sample types.

References: References: [1] Ross et al. 2011, *this volume.* [2] Fowler et al. 1994, GCA 58:3921-3929. [3] Fowler et al. 1995, GCA 59:3071-3084. [4] Goodrich et al. 2004, Chem. de Erde 64:283-327. [5] Shaddad et al. 2010, MAPS *in press.* [6] Zolensky et al. 2010, MAPS, *in press.* [7] McCoy & Reynolds, 2007. Ant. Met. News. [8] Beck et al., 2010. GCA 74:4881-4892.

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